

# J/ψ Trigger in dA



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## First Priority

- ◆ Implement a prototype of a J/ψ trigger
  - gain experience with
    - L0
    - L2 (and L2 abort, first time used in STAR)
    - L3
    - EMC
    - rates, bandwidth, etc.
  - cross-checks with simulations
    - how well can we simulate the trigger chain (rates)
- Prepare offline (reco + analysis) software
  - understand the background in triggered events
  - develop software to allow fast turn-around times during the run
    - does trigger do what we want it to do
    - improvements during the run
  - exercise EMC software
  - explore full e/h capabilities (SVT + TPC + EMC) of triggered events offline



## Second Priority

- ◆ Without trigger and  $\sim 70$  M min bias pA events:  $S \sim 100$ 
  - assuming a Yield/event  $\sim 5 * 10^{-6}$  (into  $e^+e^-$ , in  $|\eta|=1$ , at  $y=0$ )
  - Any (reasonable) trigger should only enhance the signal
- ◆ If we are lucky we have a fair shot this year
  - maybe not for publication but for **proof of principle**
  - PHENIX so far  $S \sim 30$

Meet the challenge:

- Quarkonium physics only will work if we use the full capacities of STAR (something not exercised so far)
  - L0++, L2
  - SVT (dE/dx, tracking □ e/h, □ m/m)
  - EMC (trigger, e/h, possibly □ p/p)



## The (naïve?) Plan

- ◆ Min bias dA  $\square$   $\sim 48$  kHz
  - $\square$   $\square = 2.26$  b,  $N_{\text{part}} = 7.2$ ,  $dN/d\square = 9$
- ◆ L0: trigger on 2 patches above threshold  $\square$  10 - 20 kHz
  - $\square$  L2  $\square$   $\sim 1000$  Hz
    - $\square$  input
      - $\square$  EMC tower ADCs BBC (ZDC)
    - $\square$  algorithm
      - $\square$  calculate  $z$ ,  $E_1$ ,  $E_2$ ,  $\cos(\square_{12})$   $\square$   $M_{\text{inv}} \square 2E_1E_2(1-\cos(\square_{12}))$
      - $\square$  output: yes/no
        - $\square$  store trigger info for later analysis
  - $\square$  L3, Input  $\sim 100$  Hz Max (maybe buys another factor  $\sim 2$  at most)
    - $\square$  Balance increased systematic errors with reduced statistical errors?
  - $\square$  DAQ  $\square$  50 Hz

# The Big Questions

- ◆ What can we do at L0?
  - one patch vs 2 patches (discuss rates in a later slide)
- ◆ What data and with what quality do we get at L2?
  - EMC
    - pedestals, dead channel map
    - energy resolution on trigger level (need GeV scale, not ADC)
    - cluster finder to improve
    - z-resolution
    - how fast can we get it? Need ~1-2 ms
    - what does it cost to speed it up (Tonko says, If we can prove it works, but need more speed, can make a pitch for more \$)
  - News break (for us): Transform Et □ E
- ◆ Does the L2 abort work, we never tried it, what are the problems?
- ◆ Running L2, how fast can we see that we screwed up etc.

## Simulations so far ...

Rejection/Efficiency: Working on AuAu low multiplicity simulations only up to now. Need dAu simulations, can probably get higher rejection with lower multiplicity events. Use  $S_{\text{eff}} = S/(2B/S + 1)$

### Background:

Minbias Au+Au (only last weekend did d+Au begin running...)  
Select most peripheral 50% x-section:  $dN/d\eta = 11$  (5.6 at 40%) to approx. d+Au multiplicity

### Signal:

J/Psi simulated flat in pt and h to see efficiency vs pt  
Will use more realistic pt distribution to see where most signal sits.  
Throw one J/Psi in an empty event  
Need to also mix them into a background event.

Using 3 cuts: Tower Energy (L0), Mass,  $\cos(\Delta\phi)$  (L2)



## Algorithm

- 1) Approximate the electron daughters with towers (or clusters)  
Energy, Position
- 2) Obtain vertex from BBC timing
- 3) Need at least 2 towers to make a pair (could require this at L0?)
- 4) Take all selected towers and make all possible pairs
- 5) Do cuts in  $M$  and  $\cos(\theta_{12})$ ...

$$M_{inv} \propto 2E_1 E_2 (1 - \cos(\theta_{12}))$$

Still exploring possibilities  
Towers, clusters, cluster size?



## Algorithm : *Need to explore various ideas*

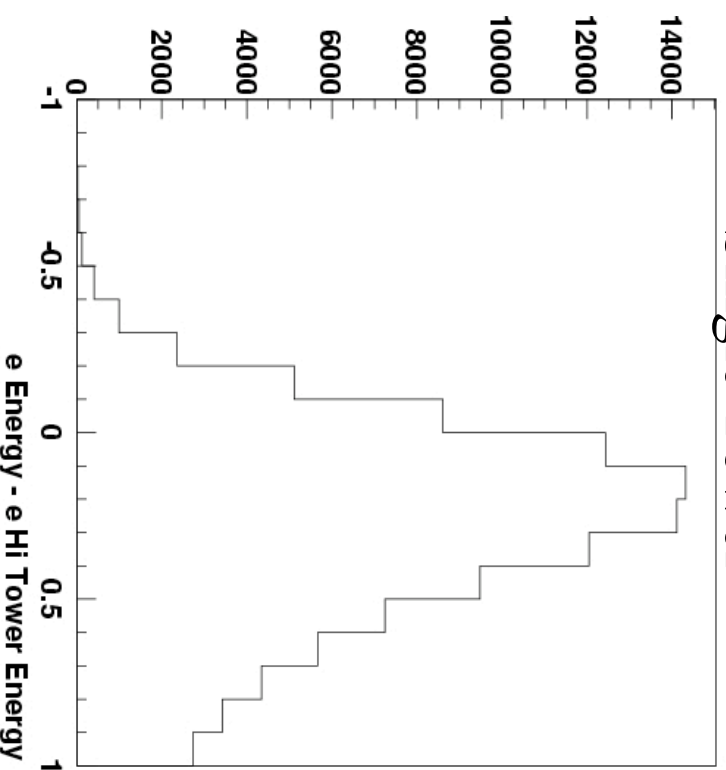
What are the best energy thresholds to use?

1, 1.5, 2 GeV? Want acceptable resolution and not to kill the signal.

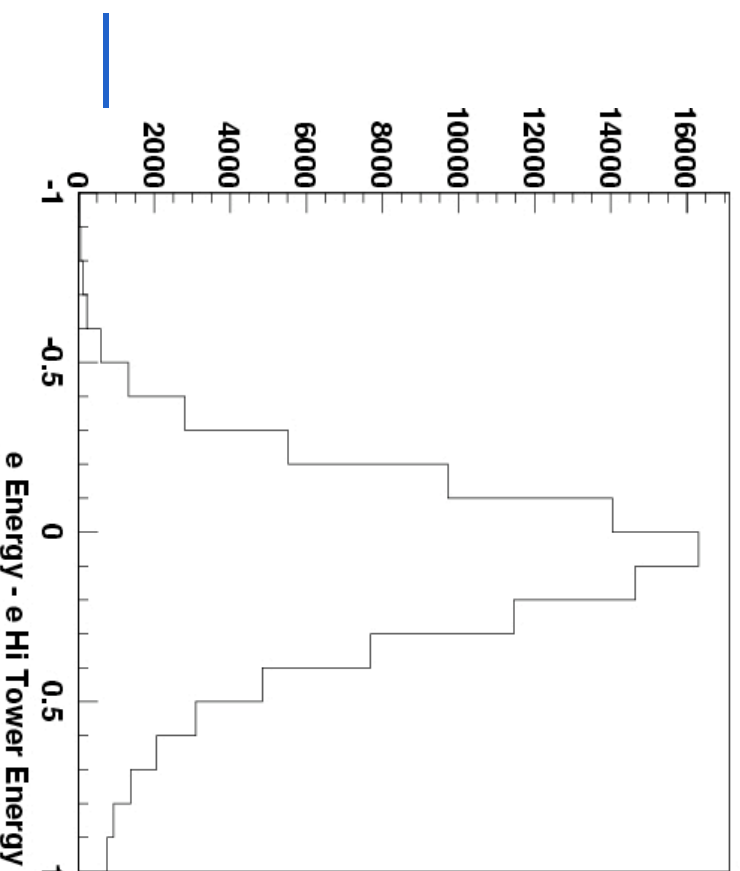
First tested with Tower Energy only: resolution not good!

Now testing various cluster approaches: 2 towers, or patches of various sizes (3x3, 5x5, 7x7, 9x9)

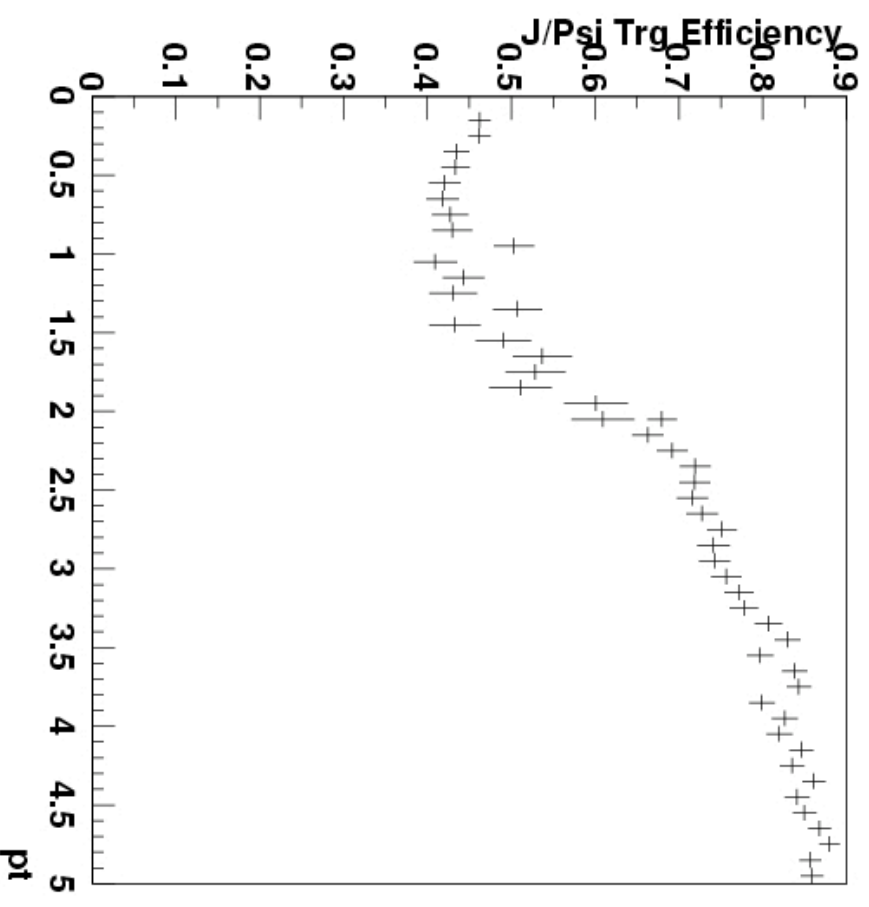
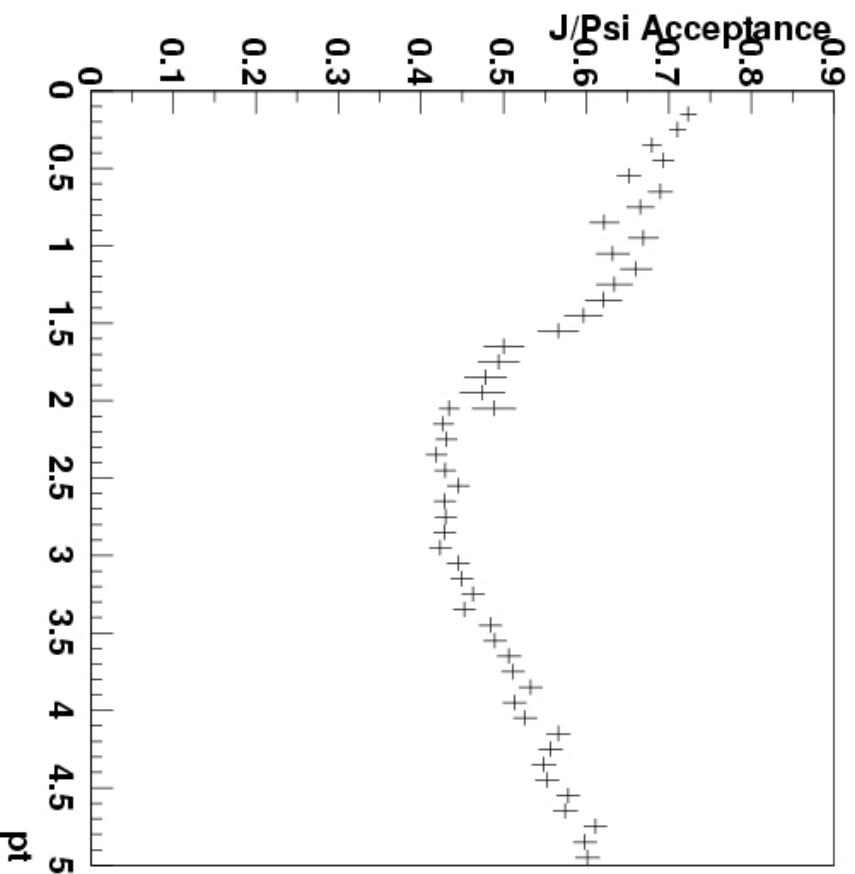
Single Tower



2-Tower Cluster



# Acceptance and Trigger Efficiency $J/\psi$

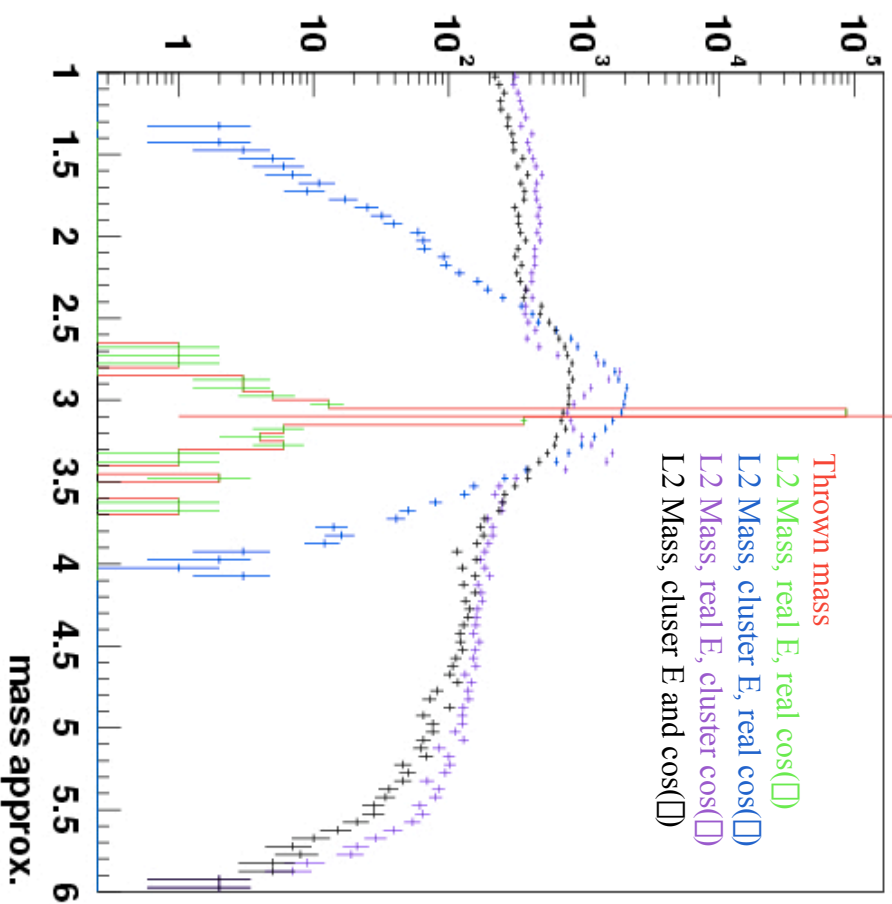


- 1) Done at mid-rapidity with full EMC, currently done with half EMC.
- 2) Trigger efficiency using Tower Energy (no clustering), and both towers with same threshold (1 GeV)



# J/ψ Mass at Level 2

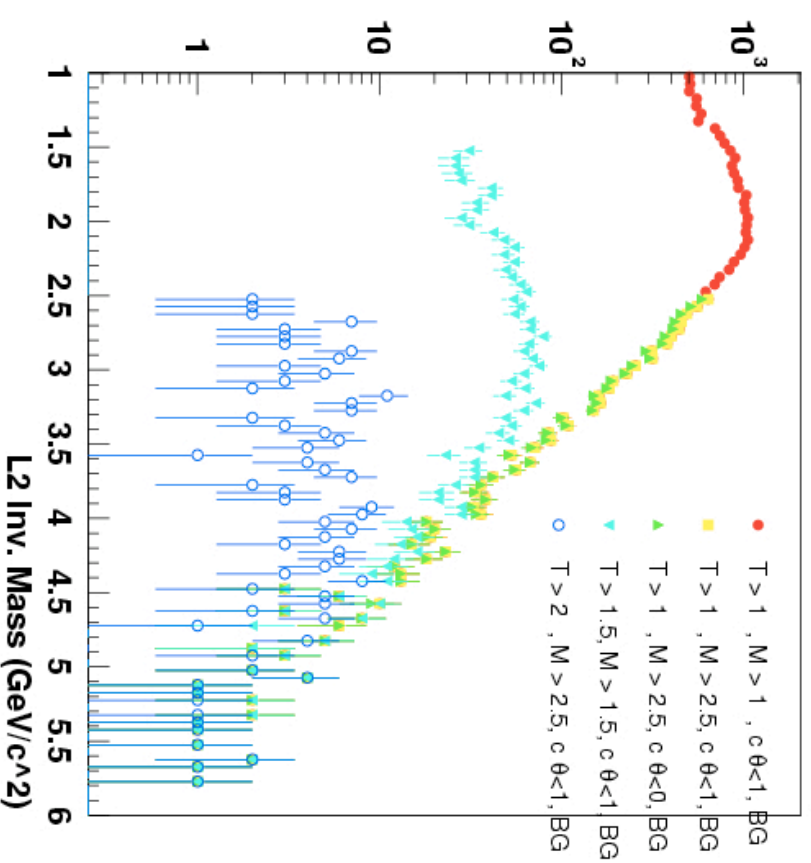
J/ψ flat in pt-η



To do: simulate with some pT slope



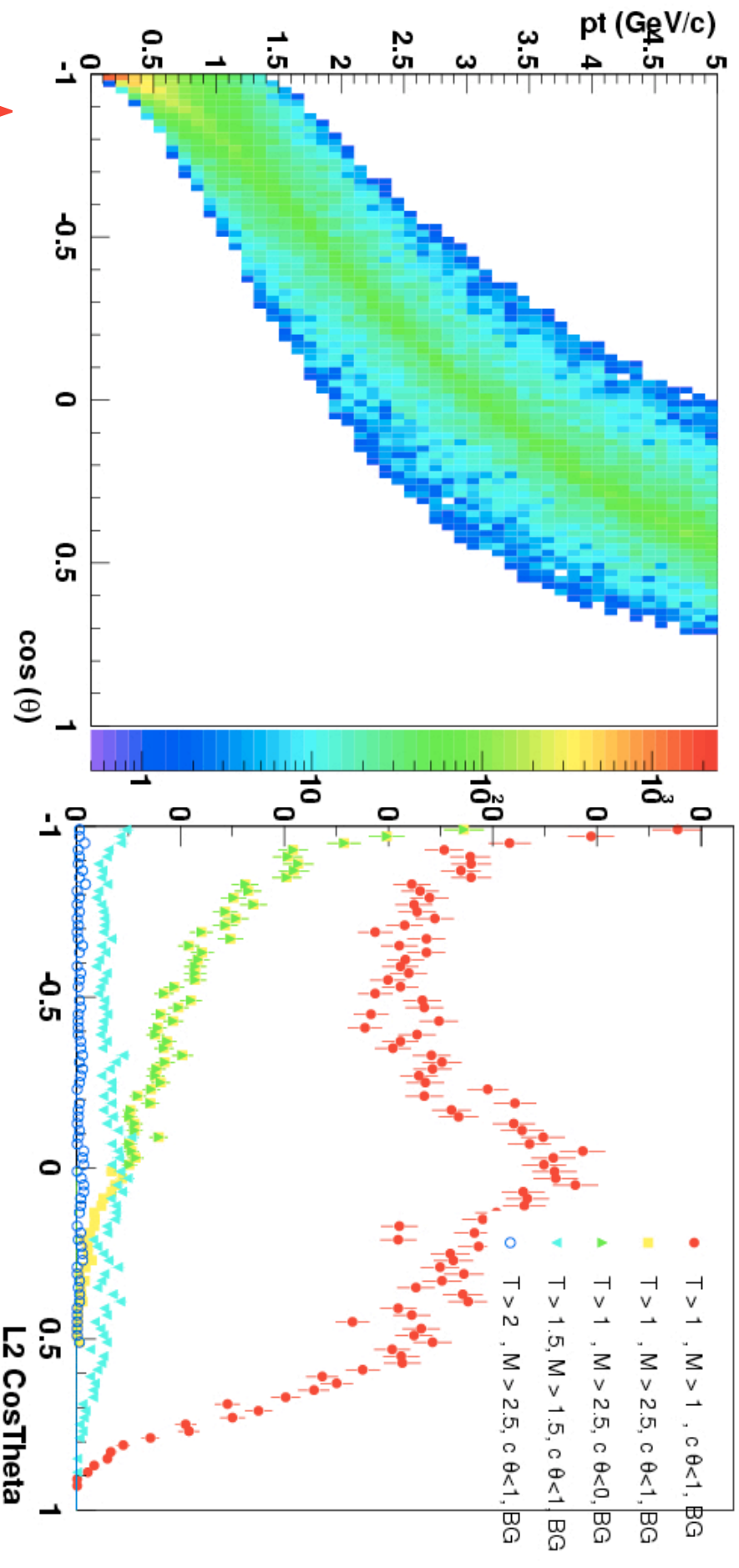
Background



# Decay Topology: large opening angle for most $J/\psi$

Accepted  $J/\psi$  (flat in  $\text{pt}-\cos\theta$ )

Background



## Background rejection (very preliminary)

L0 (tower energy)	1 Tower	2 Towers (future?)
1 GeV	1.8	2.9
1.5 GeV	3.5	9.1
2.0 GeV	8.3	55.4

L2 (tower energy, mass)	Rejection
1.0 GeV, 1.0 GeV	3.3
1.0 GeV, 2.5 GeV	6.64
1.5 GeV, 1.5 GeV	11.3
2.0 GeV, 2.5 GeV	91.6

Note: for single tower algorithm.

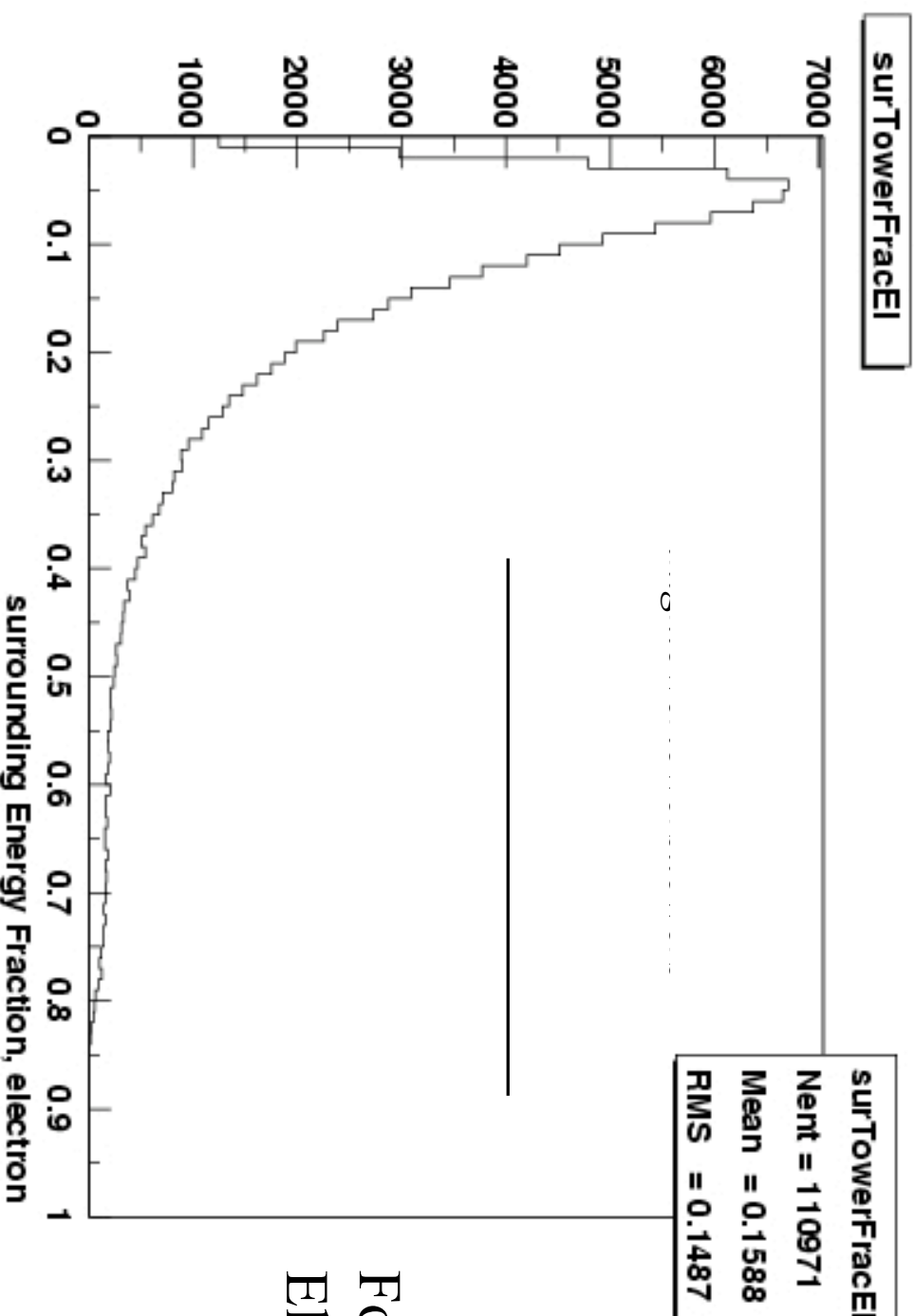
Need to revisit with clusters.

Need to quantify this as  $s_{\text{eff}}$  (include signal and background in estimate) ...



## Isolation cuts...

Compare tower (or “cluster”) energy to surrounding energy in patch



For 3x3 patch  
Electrons

## Summary

Still many simulations and tests to do to arrive at a good L2 Algorithm:

- + Low multiplicity in  $d+Au$  will reduce the backgrounds
- Signal is faint  $\sim$  “one in a million”

Key factors (i.e. need to ask for support) for

- ♦ L0, L2 trigger
- ♦ bandwidth (for test etc.)

If we're serious about J/Psi:

we have a reasonable chance next run (16 weeks  $Au+Au$ )  
for that, we need to exercise the trigger THIS RUN

J/Psi trigger fits in very nicely with Jeff's trigger scheme  
already a proof-of-principle would teach us a lot!!

if we don't test and get experience, this is bound to fail IMHO...



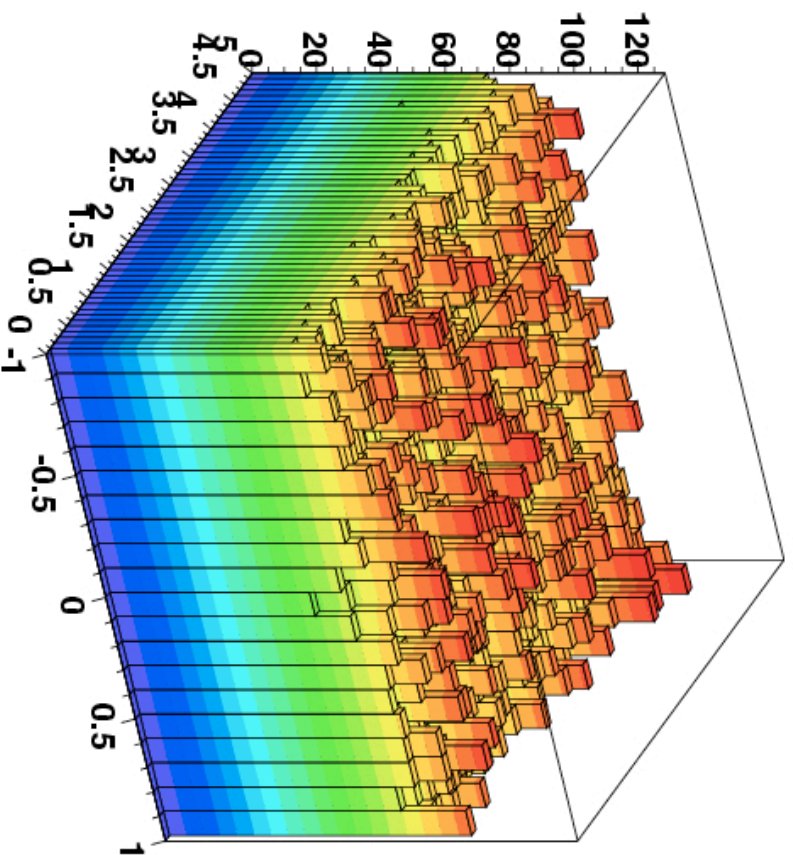


# PLAINING

MUCH WORK REMAINS TO BE DONE BEFORE WE CAN ANNOUNCE  
OUR TOTAL FAILURE TO MAKE ANY PROGRESS.

# Half EMC acceptance ( $p_T - \eta$ )

Raw



Accepted electrons with  
 $E > 1 \text{ GeV}$ ,  $0.1 < \eta < 0.9$

